

# Evaluation of Initial Active Phase Laminitis in Equine Hoofs using MRI

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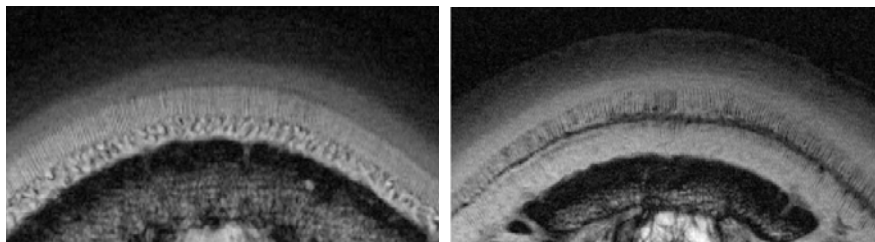
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## Introduction

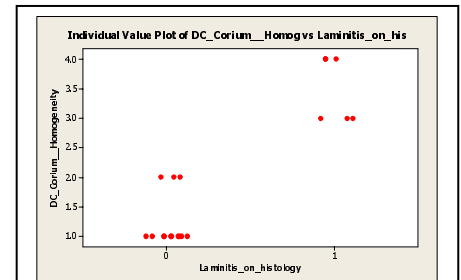
Laminitis is an expensive and emotionally draining disease for the equine industry, whose pathophysiology remains unclear. The disease carries a higher morbidity and mortality rate compared to other causes of equine lameness. The appearance of chronic laminitis with magnetic resonance imaging (MRI) in cadavers has been described, but the usefulness of MRI in evaluating laminitis in the acute patient remains open. Clinical assessment and radiographs are the current standard for assessment of laminitis despite the inability to directly evaluate the soft tissues that are affected. This cadaver study evaluates the use of MRI during the initial active phase of laminitis as a means to increase the understanding of the disease and also serves as a justification for the development of an experiment involving live horses.

## Methods

Seven feet from horses in the initial active stage of laminitis at the time of euthanasia and thirteen feet from horses without laminitis were imaged on a 4.7T/40cm magnet controlled by a Bruker Avance Console (Ettlingen, Germany). After a localizer spin echo sequence, T2\* weighted images were acquired using 3D gradient echo (GRE) sequences with FOV = 12x12x8 cm, matrix = 384x384x40, TR/TE = 16.5/3.7 ms and 2 NEX. Furthermore proton density weighted images (20 slices, thickness 2.5 mm) were created using a 2D gradient echo sequence with TR/TE = 700/4.3 ms, 256x256 matrix and 12x12 cm FOV. Representative T2\* 3D GRE images from the proximal, middle and distal thirds of each foot were evaluated by two boarded veterinary radiologists and a boarded equine surgeon. All reviewers were blinded to the animals' clinical status and histological findings. All histological samples were evaluated by a boarded veterinary pathologist. Each MR image was examined for alteration of the following: corium architecture, corium signal intensity, laminar architecture, laminar signal intensity and laminar separation. Each change was graded normal, mild, moderate or severe (1-4). Specific quantitative measurements of the MR images included: width of the corium, width of the lamina, width of the dermal tissue (lamina plus corium), ratio of lamina to total dermal tissue (lamina:dermis). Measurements and rankings for each of the MR images (proximal, middle and distal) were evaluated for their ability to accurately predict the histological diagnosis for each foot using data plots and logistic regression. Digital radiographs and MR images of the limbs were evaluated separately for evidence of laminitis and the resulting diagnoses were compared to the histological diagnosis for correlation.



**Fig 1, Left:** Transverse 3D GRE, TR/TE=16.5/3.7 ms of a normal equine foot. **Right:** Foot from a horse suffering from acute laminitis. Note the changes in architecture of the corium and the lamina as well as the separation within the proximal lamina.



**Fig 2, Correlation of loss of architecture in the distal corium vs. histological diagnosis (0=normal, 1=laminitic).**

## Results

MRI diagnosis was better than radiography with a marginal statistical significance ( $p=0.0983$ ). Evaluators were better able to reach a diagnosis in agreement with histological findings using MRI compared to conventional radiography. Logistic regression results show that moderate to severe loss of proximal corium architecture, increased laminar signal intensity, separation of lamina and middle and proximal lamina:dermis  $>0.70$  significantly predict the histological diagnosis ( $p<0.05$ ). Loss of architecture in the middle and distal corium, and lamina:dermis  $>0.70$  in the distal foot all had perfect or near perfect prediction for histological laminitis.

## Conclusions

MRI can be used to accurately diagnose the initial active stage of laminitis and provides more accurate results than conventional radiography. Loss of corium heterogeneity and increased lamina:dermis ratio ( $>0.70$ ) are extremely sensitive and specific predictors of laminitis. MRI provides the means to study the cause and pathophysiology of laminitis and gather information unattainable by any modality currently in use and provides more information to the clinician in forming a prognosis. Further study using a live animal model is warranted.

## References

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**Fig 3, Lateral radiographs of the left front limbs from a horse with laminitis (left) and a horse with a normal foot (right).**

